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ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of the results from the June 1998 administration of the Mathematics 33 Diploma Examination by the Alberta Department of Education in Canada. This information is most helpful when used with the detailed school and jurisdiction reports that are provided to schools and school jurisdiction offices. Findings indicate that 79.7% of the 5,818 students who took the test achieved the acceptable standard, and 10% of those students achieved the standard of excellence. Topics discussed include a description of the examination, achievement of standards, results and examiners' comments, multiple-choice and numerical-response questions, and written-response questions. (ASK)

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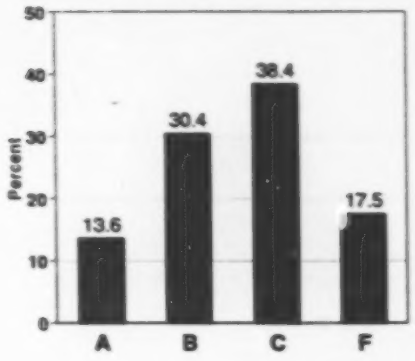
Mathematics 33

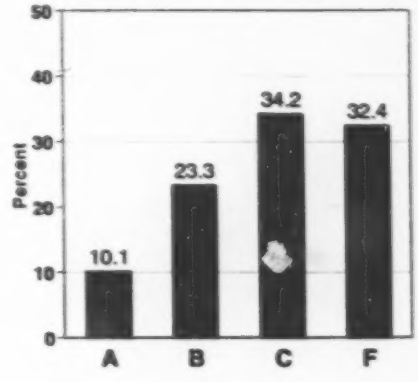
Diploma Examination Results
Examiners' Report for June 1998

ED 425 925

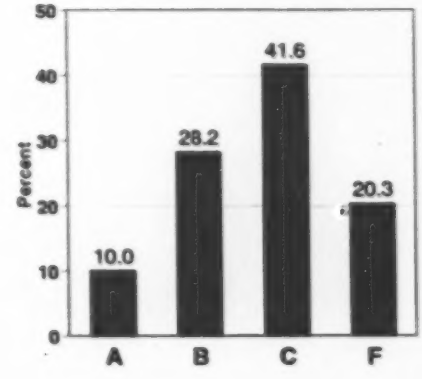
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



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The summary information in this report provides teachers, school administrators, and students with an overview of results from the June 1998 administration of the Mathematics 33 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that are provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 33 Diploma Examination consists of 37 multiple-choice questions worth 53%, 12 numerical-response questions worth 17%, and 4 written-response questions worth 30% of the total examination.

Achievement of Standards

The information reported is based on the final course marks achieved by 5 818 students who wrote the June 1998 examination.

- 79.7% of the 5 818 students achieved the acceptable standard (a final course mark of 50% or higher).
- 10.0% of the students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Mathematics 33 was satisfactory. However, the percentage of students who achieved the acceptable standard (79.7%) was significantly less than the percentage for June 1997 (85.0%). Most students demonstrated a good ability when interpreting graphs and tables that represented various functions and relations. Students were also successful when answering questions involving statistical and financial concepts using information from their data booklet. Some students had difficulty with concepts related to quadratic functions and with procedures involving multiple right triangles.

Approximately 51.4% of the students who wrote the examination were female. Of these, about 80.0% achieved the acceptable standard for a final course mark, compared with 79.4% of the male students. Approximately 10.8% of the female students achieved the standard of excellence for a final course mark, compared with 9.1% of male students.

Alberta EDUCATION

Provincial Averages

- The average school-awarded mark was 61.9%.
- The average diploma examination mark was 57.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 60.0%.

Of the 5 818 students who wrote the January 1998 examination and received a school-awarded mark, 334 had written at least one other Mathematics 33 Diploma Examination during the June 1997 to June 1998 period.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It was designed so that students who are achieving the acceptable standard should obtain a mark of 50% or higher and students achieving the standard of excellence should obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score (out of 1) achieved by students who wrote the examination.

Questions are also classified by course unit topic and mathematical understanding. The abbreviations for these areas are expanded in results that follow the table.

Blueprint

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC1	B	0.820							✔	P
MC2	C	0.693					✔			PS
MC3	C	0.565	✔							PS
MC4	D	0.618	✔							C
MC5	B	0.774						✔		C
MC6	D	0.632						✔		PS
NR1	95.6	0.432			✔					P
MC7	C	0.891							✔	C
WR1	–	0.559							✔	P/C/PS
MC8	B	0.440							✔	C
MC9	D	0.584		✔						PS
MC10	B	0.645							✔	PS
NR2	21	0.822	✔							P
NR3	79.2	0.714				✔				P
WR2	–	0.405					✔			P/C/PS
MC11	B	0.810					✔			PS
MC12	D	0.576		✔						C
MC13	A	0.697					✔			C
MC14	A	0.628	✔							C
MC15	D	0.628					✔			P
MC16	D	0.720				✔				C
NR4	15	0.506				✔				P
MC17	A	0.580				✔				P
MC18	C	0.585				✔				P
NR5	11	0.698			✔					P
MC19	A	0.788			✔					P
MC20	A	0.586			✔					P
MC21	C	0.384			✔					P
NR6	16.2	0.568			✔					P
MC22	D	0.304	✔							C

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
NR7	29.4	0.645	✔							C
MC23	B	0.511		✔						C
MC24	C	0.700		✔						P
MC25	A	0.603		✔						C
NR8	80.5	0.754	✔							P
WR3	–	0.359		✔						P/C/PS
MC26	B	0.702		✔						C
NR9	136	0.579		✔						P
WR4	–	0.590	✔							P/C/PS
MC27	D	0.758						✔		C
MC28	C	0.674						✔		C
MC29	D	0.701						✔		P
MC30	C	0.553					✔			P
NR10	264	0.731					✔			P
NR11	2175	0.299							✔	P
MC31	A	0.481						✔		C
MC32	B	0.779		✔						C
MC33	C	0.313		✔						PS
MC34	A	0.622					✔			PS
MC35	B	0.573					✔			P
NR12	285	0.248					✔			PS
MC36	C	0.528				✔				C
MC37	A	0.615	✔							PS

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 30.1 out of 49

Multiple choice: 23.0 out of 37

Numerical response: 7.0 out of 12

Written response: 9.9 out of 21

Raw Score Average for Machine-Scored Questions by Course Unit

RF	Relations and Functions	5.0	out of	8
Q	Quadratic Functions and Equations	5.3	out of	9
PR	Powers and Radicals	3.5	out of	6
RE	Polynomials and Rational Expressions	3.6	out of	6
TR	Trigonometry	5.6	out of	9
ST	Statistics	4.0	out of	6
AML	Annuities, Mortgages, and Loans	3.1	out of	5

Raw Score Average for Machine-Scored Questions by Mathematical Understanding*

Procedural (P):	13.1	out of	21
Conceptual (C):	11.3	out of	18
Problem Solving (PS):	5.7	out of	10

*Refer to Appendix D of the 1998–99 *Mathematics 33 Information Bulletin*, for an explanation of mathematical understandings.

The means on written-response questions are lower than the means on machine-scored questions. The group of students achieving the standard of excellence (80% or higher, or A) on the whole examination had a mean of 86.6% on the machine-scored questions as compared with 78.0% on the written-response questions. The group of students achieving between 50% and 79% (B or C) on the whole examination scored a mean of 67.4% on the machine-scored questions, which is higher than the 52.7% they scored on the written-response questions. The group of students below the acceptable standard (49% or less, or F) on the whole examination had a mean of 42.7% on the machine-scored questions compared with 27.1% on the written-response questions. The strengths and weaknesses of student responses on the written-response questions are discussed later in this report. An analysis of these questions can be used to maximize student performance on future written-response questions.

Multiple-Choice and Numerical-Response Questions

The following table gives results for seven questions selected from the examination. The table shows the percentage of students in four groups that answered the question correctly. The comments following the table discuss some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

Student Group	Question Number						
	NR1	NR4	MC26	MC28	NR6	NR7	MC41
All Students	35.3	39.1	54.4	63.2	57.2	43.2	60.0
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	69.4	72.1	76.4	93.1	89.9	80.6	84.5
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	26.3	31.8	49.6	60.9	53.0	34.7	55.2
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	6.2	7.2	32.5	21.8	16.0	7.4	34.2

Use the following information to answer the next question.

Bats emit a high-frequency "chirp" as they fly. They listen for the reflection of this sound off of moths, their food. By interpreting the time it takes for the sound to return, they can effectively catch moths, even in total darkness.

—from *Curtis, 1983*

Numerical Response

1. Assume that the ear structure of bats is similar to that of humans. What pathway would these "chirp" sound waves take through the ear to be detected by the temporal lobe?

Structures of the Ear

1 Semicircular canals	4 Tympanic membrane
2 Organ of Corti	5 Auditory canal
3 Eustachian tube	6 Ossicles

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: 5462

Numerical-response question 1 required students to sequence the pathway that sound waves travel through the ear to reach the brain to be interpreted. In general, most students had difficulty identifying the structures of the ear that were part of this pathway. The most common errors were that students included the semicircular canals, which are involved in detecting sensations of equilibrium, and the Eustachian tube, which equalizes pressure between the middle and outer ears.

Use the following information to answer the next question.

Some Events That Occur During Cell Division

1 Centromeres divide
2 Cytokinesis occurs
3 Identical cells are produced
4 DNA is replicated
5 Haploid cells are produced
6 Spindle fibres form

Numerical Response

4. Four events that occur in **both** human asexual and sexual cell reproduction are represented by numbers _____.

(Record your **four-digit answer in lowest-to-highest numerical order** in the numerical-response section of the answer sheet.)

Answer: 1246

Numerical-response question 4 required students to identify events that occur in both mitosis and meiosis in humans. In general, most students had difficulty eliminating the two events that did not occur in both processes. The most common error was that students included "Identical cells are produced" in the sequence. This indicates that these students do not recognize that homologous pair separation in meiosis I results in non-identical cells being produced by this process.

Use the following information to answer the next question.

The researcher obtained four samples of plants from a barley field. The chart below indicates the number of weed plants in each of the four samples.

Sample Number	Number of Weed Plants	Sample Size (Number of Plants)
1	2	20
2	8	40
3	16	80
4	10	100

6. The sample size that would produce the **smallest** 90% confidence interval for the number of weed plants in the whole barley field is

A. 20
B. 40
C. 80
*D. 100

Multiple-choice question 6 is classified as a Statistics unit question. It required students to find the confidence intervals for four samples of differing sizes (from tables in the data booklet) and then compare these intervals in order to determine the smallest one. This question was successfully answered, and it discriminated well between students achieving at the different standards shown in the table on page 4. The most common error made by students was to choose alternative A because this sample size had the smallest number of weed plants. This seems to indicate that these students have confused sample size with confidence interval.

Use the following information to answer the next question.

The farmer decided to use one acre of land for a rectangular garden. An acre is approximately 4 047 m^2. The rectangular shape that the farmer used was 25 m longer than it was wide.

9. If the width of the garden, in metres, is represented by x, then an equation that could be used to determine x is

A. $x^2 + 25x = 0$
B. $25x^2 + 5x = 0$
C. $x^2 + 25x + 4\,047 = 0$
*D. $x^2 + 25x - 4\,047 = 0$

Students also were expected to use problem-solving strategies to answer two machine-scored questions pertaining to the Quadratic Functions and Equations unit. For **multiple-choice question 9**, students were reasonably successful in formulating the correct quadratic equation for a real-life problem. However, students had more difficulty in solving multiple-choice question 33. This question, relating to the parabolic flight path of an object and its representative function, required students to find a horizontal distance using their understanding of symmetry with respect to the vertex.

Use the following information to answer the next question.

From his income, the farmer's hired employee invests $3 500 per annum in an annuity that will mature in 12 years. Interest on the annuity is compounded annually. The company offering the annuity guarantees a return of $62 587.48.

10. In order for this annuity to grow to $62 587.48, the annual rate of interest would be

A. 2%
*B. 6%
C. 8%
D. 12%

Students were successful in answering **multiple-choice question 10**, a unique question requiring problem-solving understanding related to the Annuities, Mortgages, and Loans unit. This question required students to find the interest rate in the annuity tables by using some creative interpretation techniques. Routine questions expect students to find the periodic payment or total annuity, whereas questions involving problem-solving skills expect students to find the period, interest rate, or total interest.

Numerical Response

7. In a large population of randomly breeding *Drosophila*, 1% of the population exhibits burgundy eye colour, an autosomal recessive trait. According to the Hardy–Weinberg equilibrium, what **percentage** of the population is expected to be heterozygous?

(Record your **answer as a whole number percentage** in the numerical-response section of the answer sheet.)

Answer: 18%

Use the following information to answer the next question.

> The polymerase chain reaction technique (PCR) makes it possible to produce a large number of copies of a specific DNA sequence in a relatively short time. When heated to 94°C, double-stranded DNA molecules separate completely, forming two single strands. Later, after the temperature is lowered and with DNA polymerase present, complementary DNA strands form. The process of heating and cooking can be repeated to produce as many copies of the DNA as is required.
>
> —from *Klug and Cummings, 1997*

41. PCR is similar to a process that normally occurs in cells prior to cell division. The row that identifies the site and name of this process is

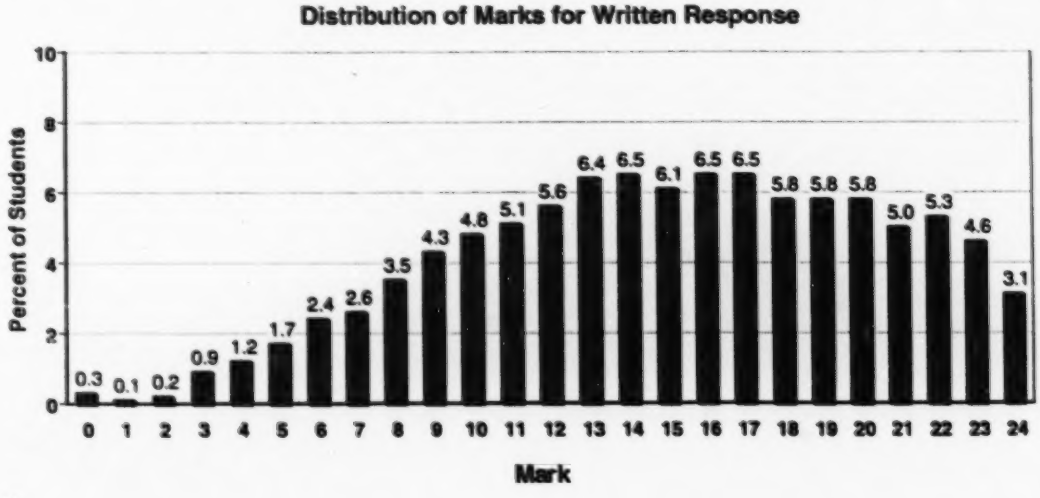
Row	Site	Process
*A.	nucleus	replication
B.	nucleus	transcription
C.	cytoplasm	replication
D.	cytoplasm	transcription

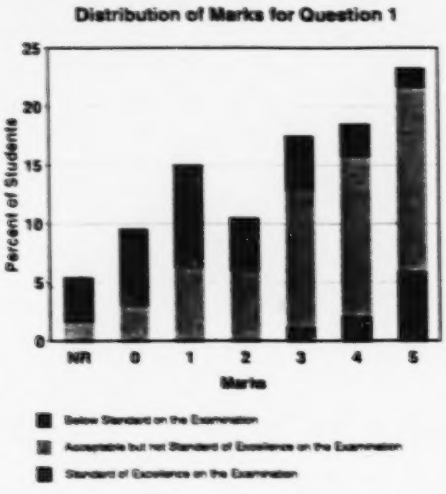
Numerical-response question 7 required students to apply Hardy–Weinburg formulas to calculate the percentage of *Drosophila* flies that are heterozygous for a recessive trait in a population, when given the percentage of homozygotes for the recessive trait. Students achieving at the standard of excellence were readily able to do these calculations; however, most other students had some degree of difficulty. The most common error was that students calculated the percentage as 50%. This indicates that these student used Punnet squares to determine the probability of two heterozygotes producing heterozygous offspring and did not recognize this as a population genetics question.

Multiple-choice question 41 required students to identify the process of replication of DNA as similar to PCR, and to identify where DNA replication occurs in cells. Students achieving at the standard of excellence were readily able to identify the process and where it occurs in cells; however, most of other students had some degree of difficulty. The most common error for these students was that they selected transcription as the process. This indicates that these students do not know the meaning of the terms used to describe the processes of DNA replication and the steps in protein synthesis.

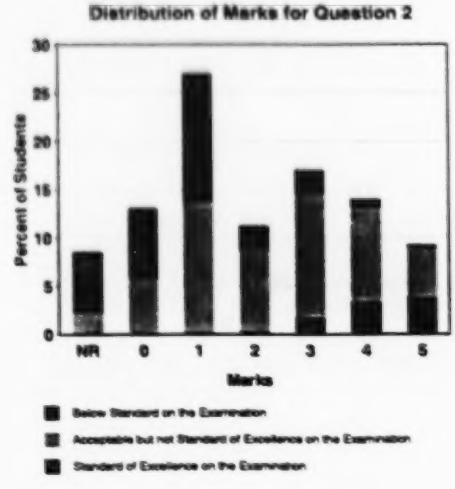
Written-Response Questions

Of the students who wrote the examination, 0.3% received no marks for both written-response questions, 73.0% received 12 marks or more out of 24, and 23.8% received 20 marks or more out of 24.



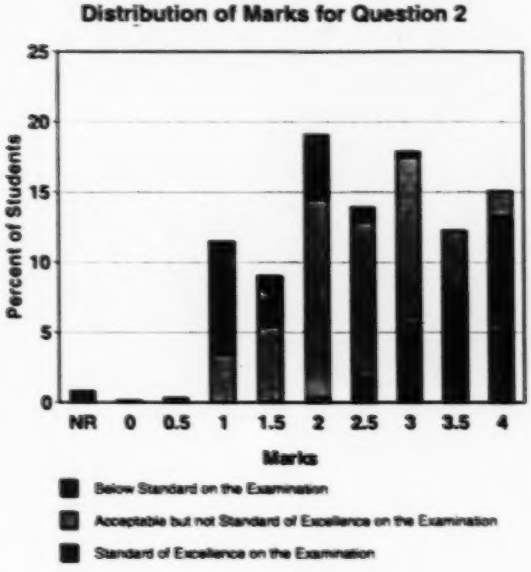


Question 1 required students to use loan and mortgage tables to calculate several values related to two borrowing options and to provide advantages and disadvantages for each of these options. The question was marked on a five-point holistic scale, and the average was 2.8 (55.9%). Teachers marking this question were impressed by students' well-written and clearly presented responses. Most students used the correct values from the tables in the data booklet, presented their steps in calculating amounts, and stated insightful reasons for and against the choice of the mortgage option. Markers were also pleased by the number of responses that included correct calculations of total amounts based on incorrectly calculated monthly payments. It was also noted that there were very few responses with rounding errors. However, teachers were concerned about the large number of "no responses" (5.5%), zeros (9.6%), and weaknesses related to communication and comprehension. Some students still used a compound interest formula instead of a table value to calculate the monthly payment, and, therefore, misinterpreted "total amount" to mean "total interest." A significant number of students used incorrect syntax (eg. $\frac{30000}{1000} = 30 \times 18.1499 = \$544.50$) and omitted dollar signs in their solutions. Instead of comparing values calculated in bullets 1 and 2 to justify their statements in bullet 3, some students incorrectly stated only the lower interest rate as the only advantage and the longer time period as the only disadvantage.



Question 2 required students to solve an applied trigonometry problem involving right triangles. The question was marked on a five-point holistic scale and the average was 2.03 (40.5%). Student responses demonstrated strengths in applying the tangent ratio or sine law and using appropriate problem-solving skills to determine the distances x and y. Markers agreed that no students should have had difficulty receiving one mark for finding the distance x (by subtracting several dimensions given on the diagram). However, of all the student responses, 21.6% (13.0% zeros and 8.6% "no responses") did not successfully perform this simple task, 27.0% received only one mark, and only 51.4% provided appropriate evidence of trigonometric application to receive 2 or more marks. Weaknesses in student responses were attributed to communication and conceptual errors. Many students did not reference their variables with the diagram or indiscriminately used the same variable (especially x, h, or y) to determine different unknown quantities. Several responses showed inappropriate rounding in intermediate steps or final answers, omitted units, failed to provide clear communication of the subtraction step in determining the distance y, misused equal signs (eg. $\tan 14° = \frac{o}{3} = 0.747$), or incorrectly found distance y by solving $\tan 22°$.

On this 12-mark question, the average mark was 7.2, or 59.7%. The acceptable standard on this question was achieved by 70.6% of the student population, and 26.3% achieved the standard of excellence with scores of 10, 11, or 12 marks (≥ 83%). Of the female students who wrote the examination, 68.4% achieved the acceptable standard and 25.4% achieved the standard of excellence. The average mark on this question for the female population was 58.5%. Of the male students who wrote the examination, 74.1% achieved the acceptable standard and 27.7% achieved the standard of excellence. The average mark on this question for the male population was 61.6%.



Question 2 Approximately 99% of the students who wrote this examination received some marks on this essay question. The question required students to identify possible causes of infertility in men or women and explain how these reduce the chance of pregnancy; evaluate ethical or societal issues related to reproductive technologies; and define trisomy, explain how it occurs, and describe a technology that could be used to determine the health of a fetus.

Students identified causes of infertility and explained how they affected reproductive capability very well. In general, students were able to identify issues related to infertility treatment and to evaluate them; however, some students had difficulty clearly indicating whether they were identifying an issue or giving a pro or a con in their evaluation of an issue. Students had the most difficulty defining trisomy and clearly explaining how it occurs. Many students seemed to confuse trisomy with X-linked inheritance. When explaining how trisomy occurs, they had difficulty using terminology correctly, interchanging the words gene, allele, and chromosome. Most students were readily able to identify a technological procedure that could be used to determine the genetic health of the fetus and partially describe it; however, many did not fully describe the procedure or made errors in their descriptions. In general, students addressed all parts of this question; presented unified, well-written, organized essays; and demonstrated the scientific background needed to answer most aspects of this question.

This question was marked holistically. Two markers read each response and each assigned a score from 0 to 4. These scores were added and then divided by 2 to obtain a raw score from 0 to 4. This raw score was then converted to a mark out of 12. On this 12-mark question, the average mark was 63.7%. The acceptable standard on this question was achieved by 78.2% of the student population, and 27.3% achieved the standard of excellence. Of the female students who wrote the examination, 82.0% achieved the acceptable standard and 29.3% achieved the standard of excellence. The average mark on this question for the female population was 65.9%. Of the male students who wrote the examination, 72.3% achieved the acceptable standard and 24.3% achieved the standard of excellence. The average mark on this question for the male population was 60.3%.

For further information, contact Elisa Rawe (erawe@edc.gov.ab.ca) or Corinne McCabe (cmccabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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